Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2006		**00-00-2006 to 00-00-2006**

4. TITLE AND SUBTITLE	
Magdalena Ridge Observatory Interferometer: Status Update	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **New Mexico Institute of Mining and Technology,Magdalena Ridge Observatory,801 Leroy Place,Socorro,NM,87801**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR’S ACRONYM(S)
	11. SPONSOR/MONITOR’S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**		**12**	

Magdalena Ridge Observatory Interferometer: Status Update

M. J. Creech-Eakman*[1], E. J. Bakker[1], D. F. Buscher[2], T. A. Coleman[1], C. A. Haniff[2], C. A. Jurgenson[1], D. A. Klinglesmith III[1], C. B. Parameswariah[1], V. D. Romero[1], A. V. Shtromberg[1], J. S. Young[2]

1 - New Mexico Institute of Mining and Technology, Magdalena Ridge Observatory, 801 Leroy Place, Socorro, NM 87801
2 - University of Cambridge, Cavendish Laboratory, Dept. of Physics, JJ Thomson Avenue, Cambridge, CB3 OHE, UK

Keywords: Optical interferometer, Magdalena Ridge Observatory, imaging, delay lines, fringe tracking, beam combiners, automated alignment

1. Abstract

The Magdalena Ridge Observatory Interferometer (MROI) is a ten element optical and near-infrared imaging interferometer being built in the Magdalena mountains west of Socorro, NM at an altitude of 3230 m. The interferometer is being designed and built by a collaboration which includes the New Mexico Institute of Mining and Technology (NMT) as the prime contractor and center for the technical team, and the University of Cambridge, Physics Department at the Cavendish Laboratory, which participates in the design and executes work packages under contract with NMT. This manuscript serves as a status update on MROI, and will present progress and milestones toward the observatory's first fringes in 2008.

2. Introduction and Background

The Magdalena Ridge Observatory is a US federally funded project being built by the New Mexico Institute of Mining and Technology (NMT) on Magdalena Ridge 32 kilometers west of Socorro, NM. It consists of two separate facilities, a fast-tracking 2.4 m telescope (MROST) and an optical interferometric array (MROI) (see Ryan et al. 2002 and Creech-Eakman et al. 2004 for details). Oversight of the observatory is performed through the Office of Naval Research and the Naval Research Lab. The main participating partners in the interferometer project are NMT and the COAST group at the University of Cambridge through an MoU established in July, 2004. Our aggressive time-schedule for "first light" anticipates the first telescope arriving in 2007, first closure phases in 2008, and commissioning and science operations commencing in 2009. In section 3 we describe the "vision'' MROI instrument and the major elements in the work-breakdown structure for the interferometer which make up the work packages associated with this facility. In section 4 we discuss some details, progress and major milestones in each of these areas. In the final section we discuss the staffing and major milestones for the overall observatory. Readers interested in the science case or the prior history of the observatory, including a description of the site and site characterization, are encouraged to see the papers listed above for more details.

3. MROI Vision Instrument

The Magdalena Ridge Observatory Interferometer is intended to be the first facility-class optical interferometer with a design that is optimized strictly for model-independent imaging. This requires that careful attention be paid to throughput, wavefront quality and optimal imaging techniques in the observatory's design. Because we are pursuing an aggressive schedule toward first-light, we plan to employ successful technologies developed at other optical interferometers whenever possible, given our design requirements and budgetary constraints.

The beam train for MROI has been designed with careful attention paid to throughput as its impact on sensitivity is a large driver for our science reference mission (see Creech-Eakman et al., 2004). The primary beam train consists of a

*M. J. Creech-Eakman, MROI Project Scientist, mce@kestrel.nmt.edu; MRO phone: 505-835-6431; www.mro.nmt.edu

telescope, atmospheric dispersion compensators (ADCs), vacuum beam transport, vacuum delay lines (DLs), a beam reducer, an automated alignment system, beam turning mirrors and pick-off dichroics to send light to various beam combiners and then to science and fringe tracking cameras. In total, there are fifteen reflections in the primary beam train from telescope primary to detectors. A secondary beam train at each telescope contains the tip-tilt and tracking systems. Tip-tilt correction of the incoming light will be performed at optical wavelengths using a pick-off dichroic and an active secondary on the telescope. No higher-order adaptive optics compensation is planned due to the small size of our primary apertures. (Figure 1)

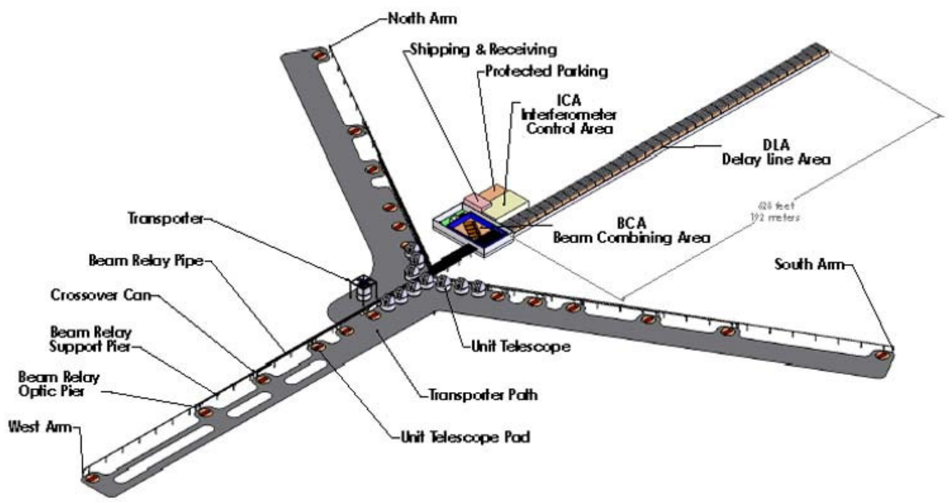

Figure 1. Illustrative layout of the MROI in the closest-spacing configuration. In this spacing the telescopes are approximately 7.5 m separated along each arm. At the largest spacing, the telescopes are separated by 350 m.

The telescopes are designed to have modest apertures (1.4 m) and are in an altitude-altitude configuration with an active secondary and tertiary. This configuration has been optimized to give a minimum number of reflections and a benign effect on the final visibility measurements of polarized light from science targets. After exiting the telescope, the 95 millimeter beam will be corrected for atmospheric dispersion using a traditional ADC design, a pair of articulated wedges. Light will then be picked-off via dichroics for tip-tilt compensation via the telescope's active secondary. For science observations in the visible, the 400-600 nm waveband will be used for correction. When science observations occur in the infrared, the 400-1000 nm waveband will be used.

After the telescope housing, the beams will enter a vacuum transport system. This system will likely consist of standard aluminum pipe at a vacuum of about 1 millibar. The full array is intended to include one central and nine kinematic pads on each arm at which to place telescopes. This array layout will allow us four scalable configurations, each with a factor of two resolution advantage along the arms over the previous configuration. The minimum intra-telescope spacing will be 7.5 meters, with the maximum baseline extending out to 350 meters.

Vacuum transport will extend into the delay line area (DLA) and beam combining facility (BCF). The optimal design for the building (see below) is the "building-within-a-building" concept used at many other interferometric facilities.

The design of these facilities has been completed and a general contractor will be chosen during summer 2006, with construction of the facility to begin in August 2006.

The delay lines themselves are an innovative design being developed at the University of Cambridge, which is under contract to NMT. These cat's eye-style delay lines use compliant wheels and an active secondary in order to eliminate the need for precision rails, running directly on the inside of the vacuum pipe. (See below and Buscher et al. 2006 (this conference 6268-93) for more details.)

After exiting the vacuum DL, light will be further reduced to a 13 mm beam and then transported in air to beam combiners for either fringe tracking or science. The BCF will include four optical tables for: optical science, infrared fringe tracking, infrared science and visitor instruments. The detailed design of the beam combiners themselves is under investigation and will be selected later this summer (see Baron et al. 2006 (this conference 6268-64) for more details). Fringe tracking will occur in the infrared, either at H (1.6 microns) or K (2.2 microns) band, depending upon the science target band. Science will be done from 0.6 microns to 2.4 microns with moderate spectral resolution and in narrow wavebands of significant spectral lines. Multiplexing several beam combiner outputs onto a single detector, using either fibers or bulk optics, is still under investigation.

The infrared detectors specified to be used for the facility are one of the crucial elements in our ability to reach our magnitude limit of 14 at H-band for fringe tracking. Detectors with the requisite noise performance are only recently being realized and we expect to let a request for proposals for these devices during the summer of 2006. These infrared devices will also be used for the infrared science camera. The optical devices likely to be used for both the optical tip-tilt and the optical science camera are electron-multiplying CCDs currently available. Figure 2 depicts many details of the beam train described above.

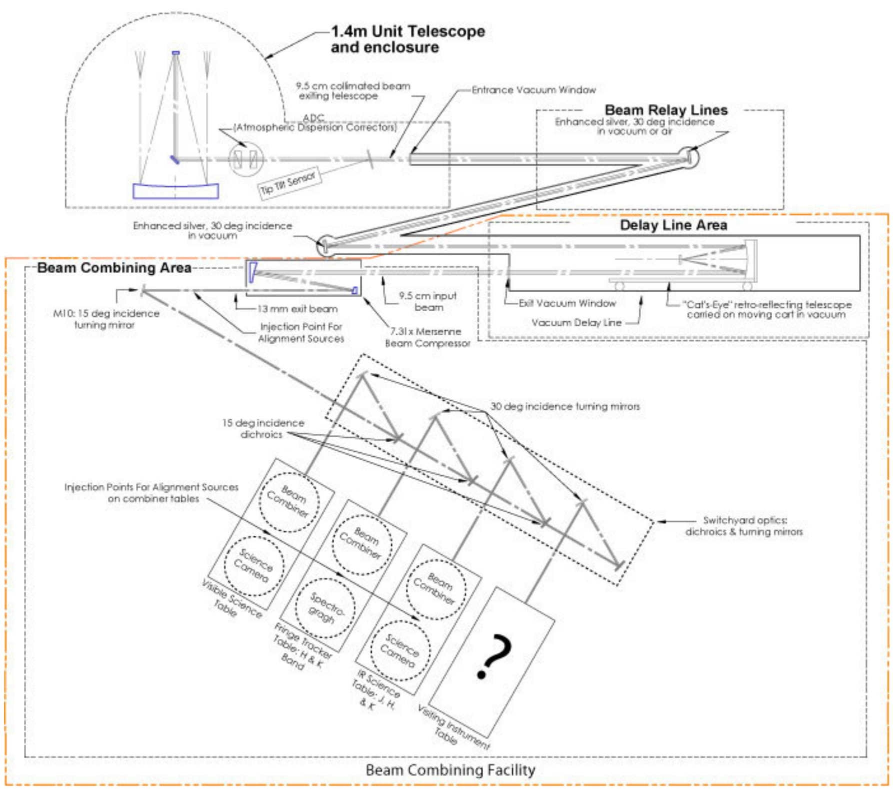

Figure 2: Illustrative layout of one MROI beam train (not to scale). Note the total number of reflections is highly constrained to maintain the best throughput and minimal wavefront distortions. The design is optimized to minimize polarization effects on the beams.

Science planning for commissioning and first-light science is underway, with formation of a science working group expected before the end of 2006. A major site characterization campaign of the Magdalena Ridge was completed in April, 2006, with plans for at least two refereed publications on results of the site characterization, including differential image motion monitoring and microthermal tower measurements to assess the seeing. Posters of these results were presented at a recent American Astronomical Society conference (See Klinglesmith and Shtromberg (2006) and Speights et al. (2005) for details and upcoming papers.).

4. Details of the Design, Status and Plans for MROI

The general optical layout for the interferometer has been discussed above. The observatory design and build tasks are being administered out of NMT under a formal Project Management structure, including a 23 item Work-Breakdown Structure (WBS) specified down to 3 levels (Bakker & Creech-Eakman, 2006). Discussion of detailed status for each of the major WBS items, along with major milestones forward to first light, follows below. Many papers were presented in this conference on major elements in the MROI, and the interested reader should refer to those papers for further details.

4.1. Telescopes

The telescopes for the MROI were conceptually designed to be an altitude-altitude mount to minimize the number of reflections (for their degradation of wavefront and throughput), and for the benign treatement of the Stokes' I, and subsequent effects on visibility calibration and fidelity. The diameter of the telescopes was a trade-off between the goal to reach 14th magnitude at H (1.6 microns), assuming group delay fringe-tracking down to an SNR of 0.77 (Buscher, 1988), assuming low-noise high-speed detectors (see below), and the constraints of the atmospheric seeing when only tip-tilt correction is available. In order to attain the closest possible spacing in the tightest configuration (in order to make images with comparable resolution to modern large-diameter telescopes) it was determined that telescopes must be designed to meet the closest spacing requirements of 7.5 meters. Tight constraints have also been placed on the field-or-regard in this configuration, so that any telescope may observe within its entire field, to within 30 degrees of the horizon, without being vignetted by an adjacent telescope's dome. Finally, our design requires that the telescopes be relocatable within approximately 8 hours, so that the entire array can be reconfigured in a few days. To do this and afford maximum protection for the telescopes, we determined that the dome and enclosure structure must be capable of supporting a telescope inside of it while the telescope is relocated. The relocation can be accomplished in a number of ways including wheeled enclosures or a crane-like lifting mechanism. An independent design study was performed which determined that the use of rails for relocation would be cost prohibitive compared to these other methods. Figure 3 shows one conceptual image of an MROI unit telescope.

The RFP for the unit telescopes, enclosures and associated relocation system was reviewed by three independent experts before being released as an RFP (Request for Proposals) in Aug, 2005. The received proposals were evaluated and we have been in negotiations with a vendor since Nov, 2005. It is anticipated that the contract will be signed shortly and we will receive the first telescope at the MROI site in late 2007. Thereafter, telescopes will be delivered approximately every 4 months. The first phase of the project is to purchase 6 telescopes.

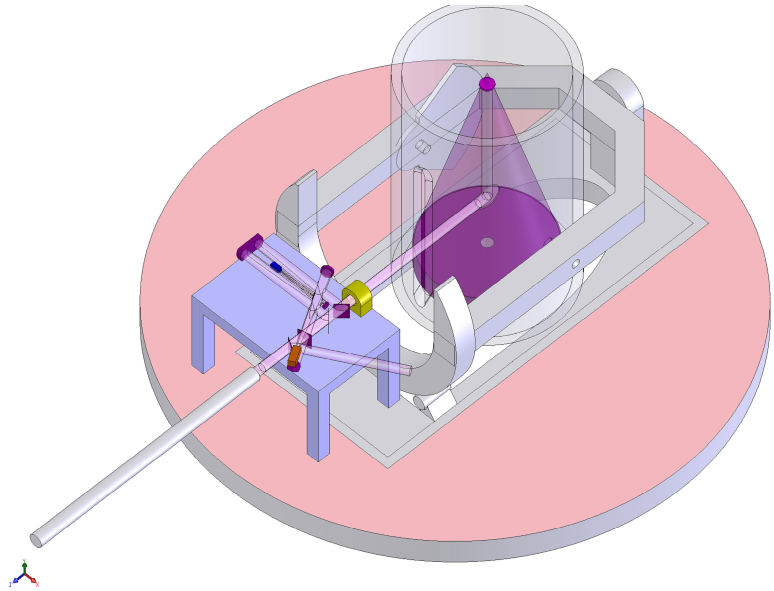

Figure 3: The conceptual layout of the MROI 1.4m alt-alt telescopes. Located directly adjacent to the telescope is the optical bench which houses the Atmospheric Dispersion Corrector and the Tip-Tilt sensor.

4.2. Tip-tilt and Automated Alignment Systems

The tip-tilt system will operate using optical light picked off by a dichroic on the optical table adjacent to the telescope. The operational wavelength will depend upon the waveband of interest for science data. That is, if the science data is being taken in the infrared, then the entire waveband from 400-1000 nm will be used for tip-tilt correction and when science data is taken in the optical (600-1000 nm) then tip-tilt will be performed using 400-600 nm light.
Tip-tilt will be performed using the secondary of the telescope via a closed-loop system, nominally at 10 Hz. We are currently planning to modify off-the-shelf electron-multiplying CCD cameras (e.g. E2V-type cameras) to serve as the sensors for the tip-tilt system. Investigatory studies are underway to modify one of these cameras at the University of Cambridge.

A conceptual design of the automated alignment system has been completed. The current design includes primary and secondary fiducials and white light and laser injection at an optical bench located after the delay line exit point and the Mersenne beam reducers and before the beam combining tables, in the BCF (see Figure 4). The main features of this alignment system include automated pop-up quad-cell detectors, beam blocks and port for external lighting and imaging of positions of various components in vacuum cans throughout the system. Ideas for this system were derived from several existing interferometers' infrastructures. Several components for this system including slides and CCD cameras are currently under test in the lab. For a complete discussion of this system see Jurgenson et al., 2006 (this conference 6268-144). A preliminary design review and final down-select of components is scheduled for July, 2006.

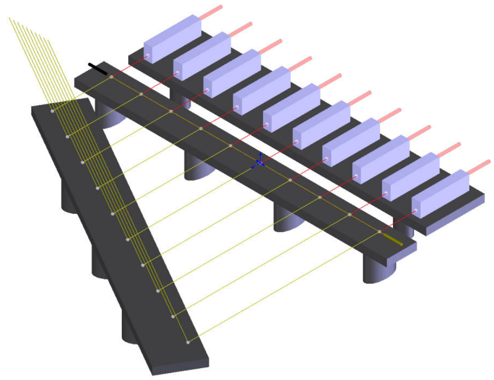

Figure 4: Conceptual layout of the primary fiducial bench for the automated alignment system which is located between the Mersenne beam condensers (RHS) and the beam turning mirrors (LHS).

4.3. Vacuum Transport System

After exiting the telescopes, all stellar light will be transported via aluminum vacuum pipes from the telescopes enclosures into the BCF and DLA buildings to negate the effects of longitudinal dispersion. The vacuum will nominally be held at 1 millibar throughout the system, with the beams having a 95 millimeter diameter upon exiting the telescopes. The system has been designed to use a minimum number of reflections to direct the beams into the delay lines for compensation, with each arm having either 2 or 3 reflections along the path, depending upon geometry. Vacuum pipes will be nominally 200 millimeter diameter and approximately 6 millimeter wall thickness. At vacuum cans, where steering optics are housed to turn and align beams, attachments between the pipes and the cans will be via compliant bellows (Figure 5). Vacuum pipes will be connected to non-conducting pipe at the entrance to the buildings, via bellows, to minimize both the possibility for vibrations (e.g. pipes coupling to the wind) and lightning conduction into the BCF and DLA buildings. Approximately 2 kilometers of pipe will be needed to support the full array infrastructure.

A preliminary design review was held in Dec, 2005 and we expect to complete this design after bringing on-board a new lead opto-mechanical engineer on the project.

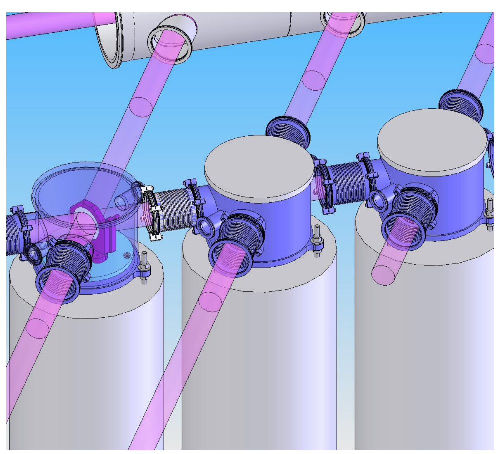

Figure 5: Conceptual layout of the MROI crossover vacuum cans containing optics and connected via bellows.

4.4. Interferometer Buildings

Exciting progress has been made in the last two years on the interferometer buildings for MROI. These buildings include a delay line area (DLA), a beam combining facility (BCF) and an interferometer control area (ICA) (See Figure 6). The DLA is 192 meters long and includes enough width to support 10 delay lines on 61 cm centers, with extra area for an overhead gantry crane for installation. The BCF is a room-within-a-room design which is a total (inner and outer rooms) of 574 square meters. It houses all the turning mirrors, the beam condensers, the primary alignment fiducials and all the beam combiners and cameras on 3 tables, with a 4th table available for visitor instruments. The ICA is 466 square meters and includes a server room, interferometer control room, electrical and optical labs, shipping and receiving, kitchen facilities, bathrooms, a small coat/locker room and scientists' and director's offices. On the far end of the ICA is the mechanically and structurally isolated mechanical room in which the HVAC, vacuum pumps and other large mechanical equipment is housed. Cooling is performed via chilled fluids from which heat is exhausted across the parking lot, down-wind from the telescopes.

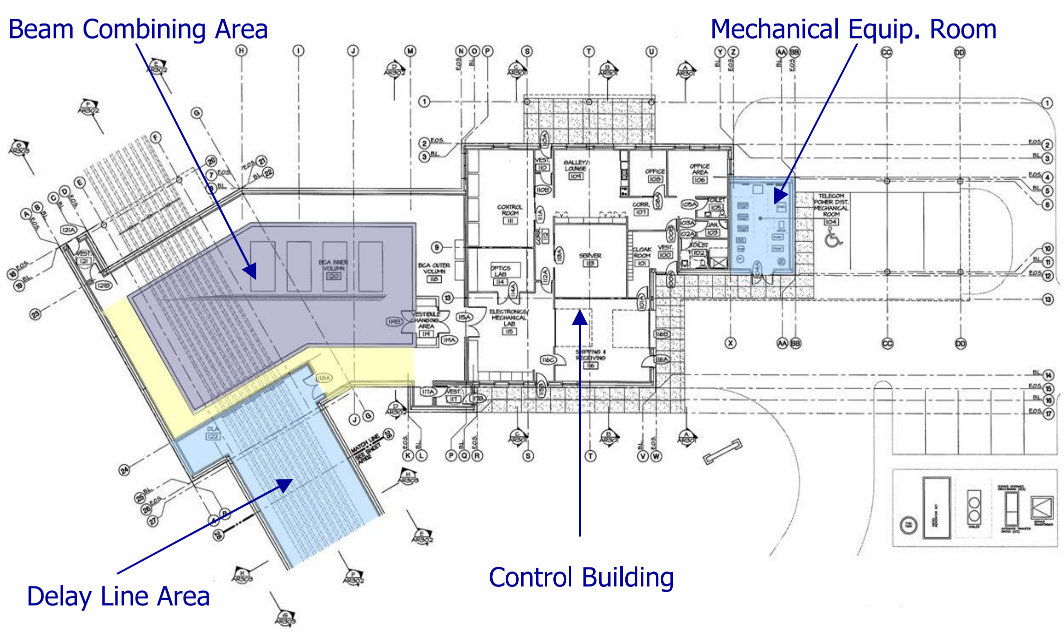

Figure 6: Architectural cross-section for the MROI buildings. Major areas are labeled, with the Delay Line Area extending below the page for a total of 192 m.

Included in the design work for the buildings are the array arms for the vacuum transport pipes, roadways for the telescope transporter unit, and telescope pads. There will be a total of 28 pads on the MROI site for the 4 configurations of the telescopes and approximately 200 concrete piers on which to support vacuum cans and pipes. Progress on this part of the infrastructure has been hampered due to the delay in signing our telescope contract.

The RFP for the buildings and array infrastructure was released in March, 2005 and we were very pleased to have among the bidders *M3 Engineering and Technology Corporation*, who were selected via a competitive process as our architects. We have followed the lead of other interferometers like SUSI and CHARA and also retained a thermal consultant, Joe Accetta (*JSA Photonics*), to perform thermal design analysis and make recommendations to *M3* for the design of our buildings. Included in the thermal requirements are not more than 0.1^{o} C horizontal variation across the inner BCF, no creation of convection currents in the inner BCF, and not more than 1.0^{o} C horizontal variation across the DLA during any 24 hour period. As results of this design, it has been determined that a completely passive DLA and a passive, but insulated, inner BCF (with a thermally controlled outer BCF) will meet our requirements. The design has also included placing insulation along the foundation walls (underground) of the building to allow the ground beneath the buildings to behave as a thermally stabilized heat sink separated from the adjacent soils. Great care is also being

taken to vibrationally isolate all sections of the buildings from each other and from moving objects (e.g. trees) on the summit. This is assisted by the lack of bedrock on the site, which instead consists primarily of soil, clay and cobbles.

A critical design review of the building design was held at NMT in March, 2006. The conclusion of this review was that the buildings met all our requirements and did not include any evident "frills" which should be eliminated. Four general contracting companies have been pre-qualified to bid on the work and will receive the bid packages in June, 2006. We are planning to select a contractor and break ground in Aug, 2006 and anticipate the building and array infrastructure work to take approximately 13 months.

4.5. Delay Lines

Our innovative delay line design is the brain-child of the COAST group and is driven primarily by cost factors and the need to perform all the delay and atmospheric compensation in a single pass, again to minimize reflections and wavefront degradation. These delay lines are being designed and built by Cambridge under contract to NMT and are discussed in detail by Buscher et al. 2006 (this conference 6268-93). They include compliant wheels which run directly on the inside of the vacuum pipe and a steerable secondary which is capable of correcting for +/- 5mm excursions in the pipe's straightness. The plan is to develop look-up tables which each cart will employ as it travels along the delay line pipes, to keep the beams traveling out at the same horizontal height. Other innovative features included in the design are an inductive pick-up for power, which runs along a wire in the bottom of the pipe, and RF communication with the cart computer (Figure 7). Due to the sensitive nature of MROI's location with respect to the VLA and Langmuir Laboratories (both of which are sensitive to RF noise), special care is being taken to terminate this RF communication and avoid polluting the RF environment on Magdalena Ridge. (See Parameswariah and Jurgenson, 2006 (this conference 6268-149) for further discussion.)

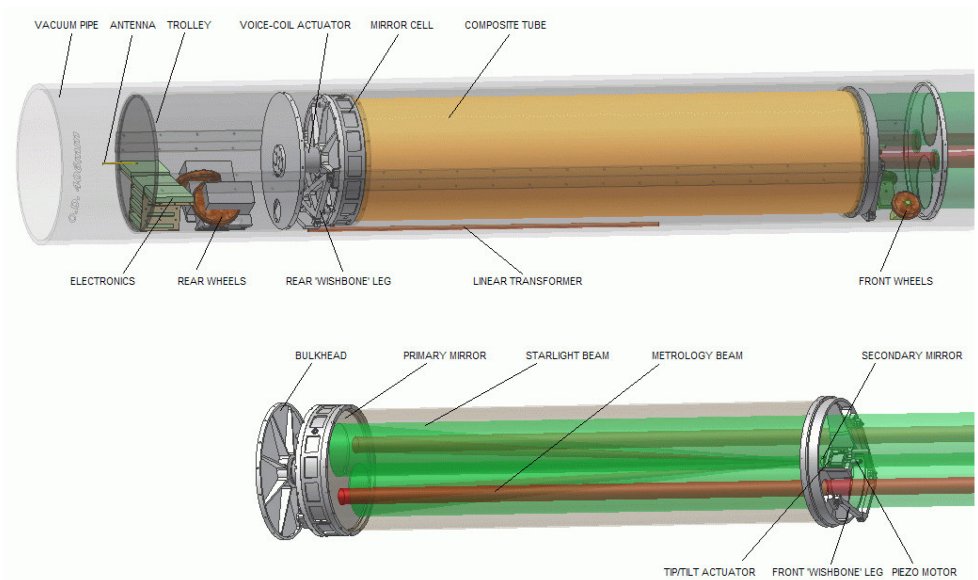

Figure 7: MROI delay lines being designed and built by Cambridge. The top figure shows the rear of the delay line carriage in the pipe. The bottom figure shows the front of the cart with the stellar and metrology beams traveling orthogonal paths through the cat's eye system.

Because this design is new to the optical interferometric community, two risk reviews were held to determine if the concept was feasible before moving ahead. In the first review in Nov, 2004, risk-reduction experiments were identified by Cambridge and an external team of experts to determine what parts of the concept were most risky or likely to fail. In the second review in July, 2005, the results of these experiments were presented to the external team. This team gave NMT a "green light" to have Cambridge proceed with the prototype cart design, which will be completed in the fall, 2006. We expect to review this prototype cart in 2006 and take receipt of the first fully tested cart for MROI in spring, 2007.

4.6. Beam Combiners, Cameras and Detectors

The infrared beam combiner and camera designs are still under study by NMT and Cambridge in collaboration. The current most-likely scenario for the fringe tracker beam combiners is a nearest-neighbors pupil plane combination, using bulk optics and pinholes for spatial filtering. This conservative design is considered the forerunner due to the importance of preserving photons to reach our 14th magnitude limit at H band. Various pupil plane and image plane combinations using 4 to 8 way simultaneous combination for the science combiner are also being studied, primarily at Cambridge. (See Baron et al. 2006 (this conference 6268-64).) Camera designs for the optimal system to receive the interfered beams are being studied at NMT. These include 4 and 5 way bulk optics schemes to bring the outputs of the beam combiners into the cryogenic fringe-tracking camera (Figure 8). The full array implementation (10 telescopes) will likely require 4 fringe tracking cameras if these designs prove feasible. They currently include pinholes in the scheme, for spatial filtering, which will occur on the cold surface. The cold portion of the camera will be optimized and baffled for thermal backgrounds as we expect to be operating in the thermal regime at K band (2.0-2.4 microns). Dispersion of the group delay fringe will be across approximately 5 pixels at H or K band. The infrared science camera will have selectable dispersions with spectral resolving powers of roughly 30 and 300, and perhaps higher dispersion around 1200. Optimal schemes including grisms, gratings, prisms and cold fibers are still being investigated. Down-select of the optimal design for these systems will be held in Aug, 2006, most likely with an external review team. Optical beam combiners and cameras for science are not part of the first phase of MROI. We are investigating teaming options and external funding for these optical instruments.

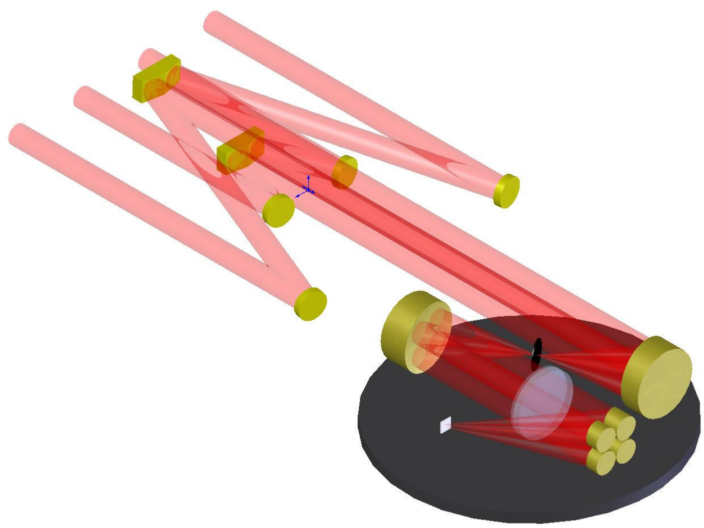

Figure 8: A conceptual design of a four beam feed system from the beam combiners into the Fringe Tracking cameras. The portion to the RHS over the dark circle is presumed to be on the cold surface and includes parabolas, a pinhole, a Direct View Prism and the array.

The detectors for MROI are integral to our successful tracking of 14th magnitude objects. Our current plans require us to reach 1 electron read-noise levels with arrays when multiply sampled (though we only lose 0.5 magnitudes when operating at 3 electrons read-noise). The infrared array market is on the brink of being able to produce arrays of this capability in a repeatable way. Follow-on technologies to the Hawaii and PICNIC arrays are being optimized for wavefront sensing and infrared adaptive optics applications (Finger et al. 2004). We expect to let a common set of RFPs in a consortium with Gemini/NOAO and ESO for these devices in the summer of 2006, with anticipated delivery in about 18 months. For the optical science instrument, we expect to capitalize on the electron-multiplying CCDs currently available on the market.

4.7. Control and Offline Software

The need for a real-time, massively parallel control software architecture with which to run the distributed architecture of the MROI is a well-known issue for interferometers. Because we have the goal of making the MROI a facility-class instrument which is highly automated for efficiency, and available to general astronomers for use, it was important to pick a control software architecture that was capable of the multiple needs presented by such an optical interferometer (see Parameswariah et al. 2006 (this conference 6268-137) for details of the MROI control system). In March, 2005 a review and trade-offs of available software frameworks (including EPICS, and the software being used to operate the Keck Interferometer, ALMA and IOTA) for this task was made, and we decided to pursue the use of the Real Time Control (RTC) software developed by the Jet Propulsion Laboratory (JPL), Caltech. This software has been used to run the Keck Interferometer, the delay lines on the CHARA array, and several interferometry testbeds at JPL. NMT has subsequently entered into an agreement with JPL to learn how to use the software, develop certain modules within the framework, and have RTC ported over to a real-time Linux operating system. The main advantages for NMT in this development are the lower cost of Linux-compatible hardware, the knowledge of a system already in use at other interferometric facilities, and the savings of many person-years worth of effort in its development. For more information on the original development of RTC see Lockhart (2002).

Along with control-software, we recognize the need to develop data calibration and reduction software that will allow us to debug the instruments and produce calibrated images with the interferometer. Our plans here are still developing, but include utilizing existing technology (e.g. OIFITS), imaging reduction programs like BSMEM, and to make use of existing planning tools available through the Michelson Science Center and the Mariotti Center. We will also rely on the experience of people experienced with imaging techniques at the NRAO and within the Cambridge team (Lawson et al. 2004 (this conference 6268-69)). To help in these efforts, we plan to hire a scientist-programmer to help with this development in the near future.

5. Staffing and Milestones

The MROI has moved forward tremendously in the last two years in many of its design and development efforts. Continuing on the current schedule, we plan to hire approximately 5 more employees (engineers, programmers and scientists) before the end of 2006. We also anticipate openings among the faculty in the Cambridge and NMT Physics departments, with positions also available for postdocs and students in both locations. The total complement of FTE on the MROI team at NMT will be approximately 15, with another 6 FTE at Cambridge. On the current schedule outlined above, we expect to finish the MROI buildings in Sept, 2007 and begin installing the building and array infrastructure at that time. The vacuum transport system and delay lines will take approximately 6 months to install, meaning that MROI will be prepared to attempt first fringes in mid-to-late 2008 when the second and third telescopes arrive and pass their site acceptance tests. Telescopes four through six will continue to be delivered through late 2009, at which time commissioning of the first phase of the array will begin. After operability and images are demonstrated in phase one, we will seek additional funds for the last four telescopes and associated infrastructure for MROI.

MROI will be the first facility class optical interferometer developed and optimized solely for an imaging campaign. We welcome community input for external design reviews and collaborations. Please contact Michelle Creech-Eakman, Eric Bakker, Chris Haniff or David Buscher for questions or further details. All contact information is available via the MRO website: http://www.mro.nmt.edu.

Acknowledgements: We wish to thank several people in the community who have participated in design discussions and reviews associated with MROI. These include principally: Jim Bell, Nat Carleton, Mark Colavita, Dennis Coyne, Martin Fisher, Michael Hrynevych, Bertrand Koeler, Sergio Restaino, Steve Ridgway, Mark Swain and Wes Traub.

The Magdalena Ridge Observatory (MRO) is funded by Agreement No. N00173-01-2-C902 with the Naval Research Laboratory (NRL). MRO Interferometer is hosted by the New Mexico Institute of Mining and Technology (NMT) at Socorro, NM, USA, in collaboration with the Univeristy of Cambridge (UK).

References :

Baron, F.,et al, 2006, SPIE (this conference), “Advances in Stellar Interferometry”, ed. by J. Monnier et al., Vol 6268.
Buscher, D. F., 1988, PhD Thesis, University of Cambridge, UK.
Buscher, D. F. et al., 2006, SPIE (this conference), “Advances in Stellar Interferometry”, ed. by J. Monnier et al., Vol 6268.
Creech-Eakman, M. J. et al., 2004, SPIE, “New Frontiers in Stellar Interferometry”, ed. by W. Traub, Vol 5491, p. 405.
Finger, G. et al., 2002, SPIE, “Optical and Infrared Detectors for Astornomy”, ed. by J. Garnett and J. Beletic, Vol 5499, p. 97.
Jurgenson, C. A., et al., 2006, SPIE (this conference), “Advances in Stellar Interferometry”, ed. by J. Monnier et al., Vol 6268.
Klinglesmith, D. A. and A. V. Shtromberg, 2006, AAS, Vol 207, 82.208.
Lawson, P. R. et al., 2006, SPIE (this conference), “Advances in Stellar Interferometry”, ed. by J. Monnier et al., Vol 6268.
Lockhart, T., 2002, SPIE, “Advanced Telescope and Instrumentation Control Software II”, ed. by H. Lewis, Vol 4848, 197.
Parameswariah, C. and C. A. Jurgenson, 2006, SPIE (this conference), “Advances in Stellar Interferometry”, ed. by J. Monnier et al., Vol 6268.
Parameswariah, C. A. et al., 2006, SPIE (this conference), “Advances in Stellar Interferometry”, ed. by J. Monnier et al., Vol 6268.
Ryan, E. V., et al. 2002, DPS, AAS, Vol 34, p. 898.
Speights, J. C. et al., 2005, AAS, Vol 207, 82.08.